US007895949B2

(12) **United States Patent**
Bointon et al.

(10) **Patent No.: US 7,895,949 B2**
(45) **Date of Patent: Mar. 1, 2011**

(54) **DEVICE, METHOD AND APPARATUS FOR LIFTING A RAILWAY RAIL**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 138 days.

(21) Appl. No.: **11/996,062**

(22) PCT Filed: **Jul. 7, 2006**

(86) PCT No.: **PCT/GB2006/002536**

§ 371 (c)(1),
(2), (4) Date: **Apr. 2, 2008**

(87) PCT Pub. No.: **WO2007/010192**

PCT Pub. Date: **Jan. 25, 2007**

(65) **Prior Publication Data**

US 2008/0197330 A1 Aug. 21, 2008

(30) **Foreign Application Priority Data**

Jul. 20, 2005 (GB) 0514907.5

(51) **Int. Cl.**
E01B 29/04 (2006.01)
E01B 29/44 (2006.01)

(52) **U.S. Cl.** **104/2**; 104/13

(58) **Field of Classification Search** 104/2, 104/7.1, 7.2, 9, 4, 13, 15, 16, 17.1, 17.2
See application file for complete search history.

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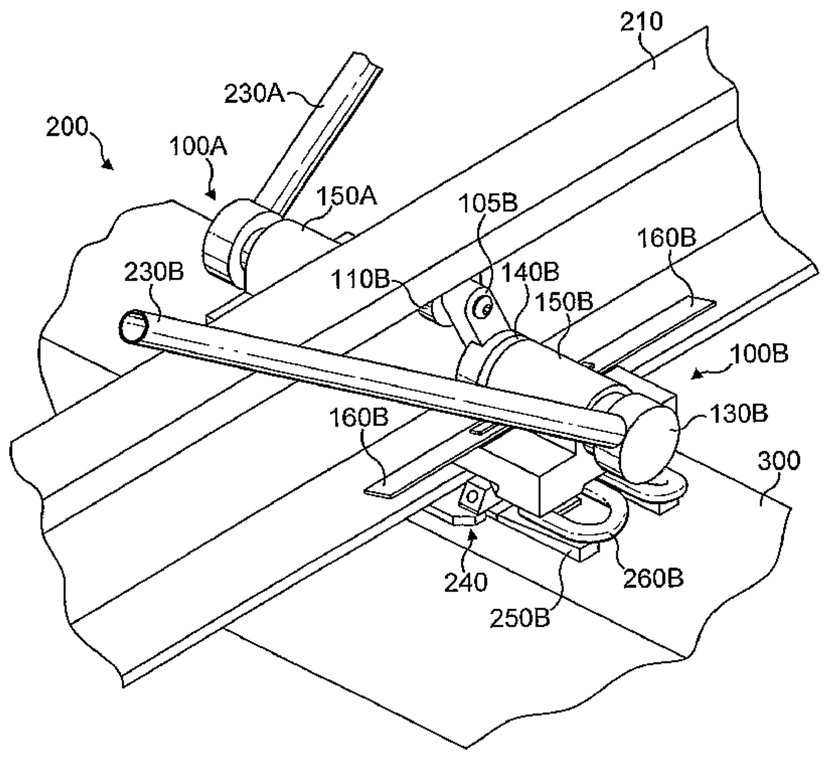
Assistant Examiner—Zachary Kuhfuss
(74) *Attorney, Agent, or Firm*—Marshall, Gerstein & Borun LLP

(57) **ABSTRACT**

A railway-rail-lifting device for lifting a railway rail comprises an arm (**105**) and a roller (**110**) rotatably mounted to the arm (**105**). The arm (**105**) is operable to be rotated to bring the roller (**110**) to bear on the rail such that the roller (**105**) exerts a lifting force thereon. Securing means are operable to releasably secure the device to a rail fastening assembly.

21 Claims, 9 Drawing Sheets



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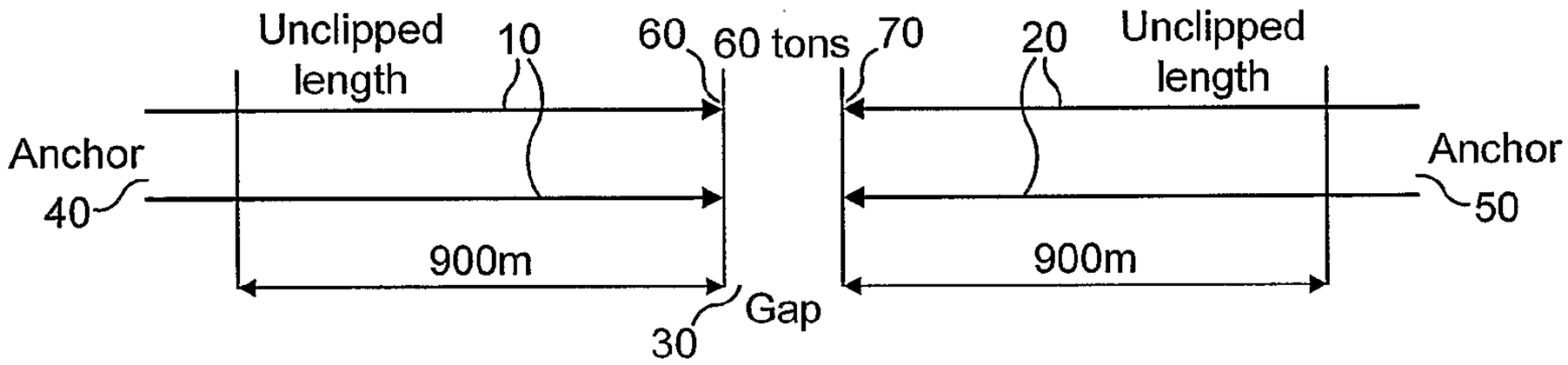

Unclipped
length
10
60
60 tons
70
20
Unclipped
length
Anchor
40
Anchor
50
900m
900m
Gap
30

FIG. 1A

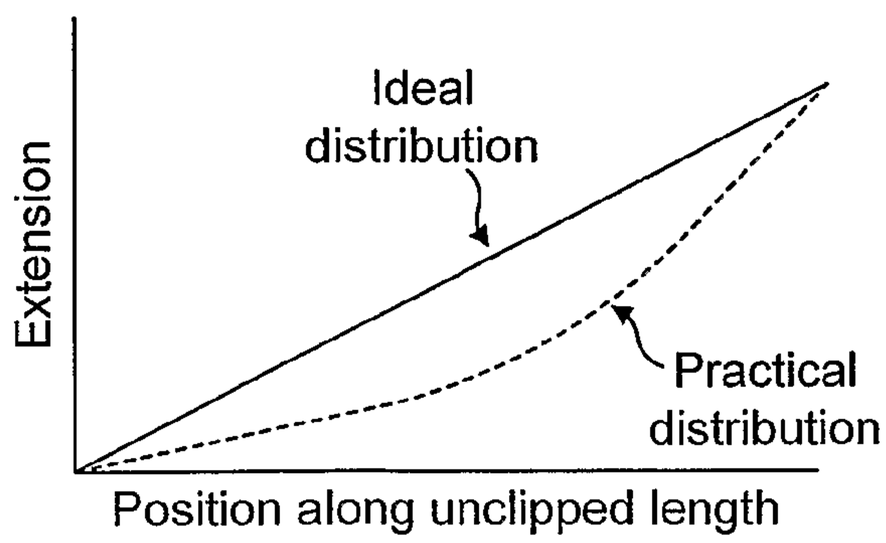

Ideal
distribution
Extension
Practical
distribution
Position along unclipped length

FIG. 1B

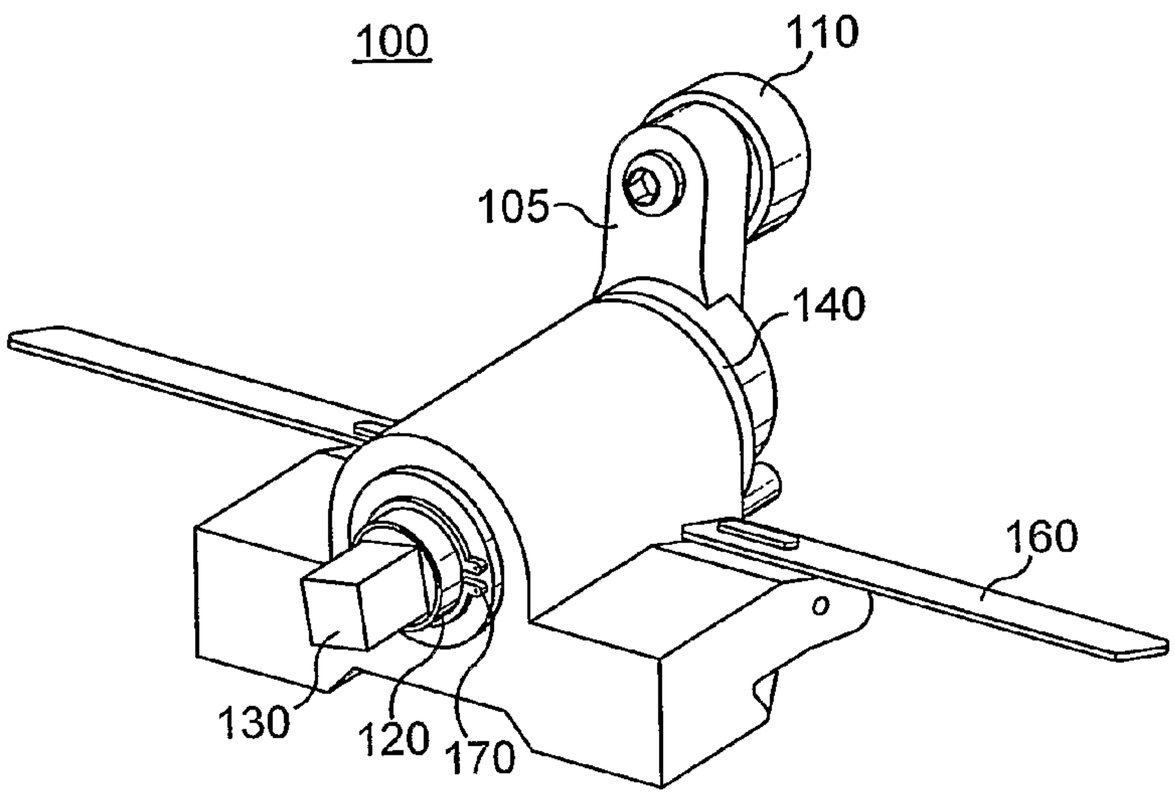

100
110
105
140
160
130
120
170

FIG. 2

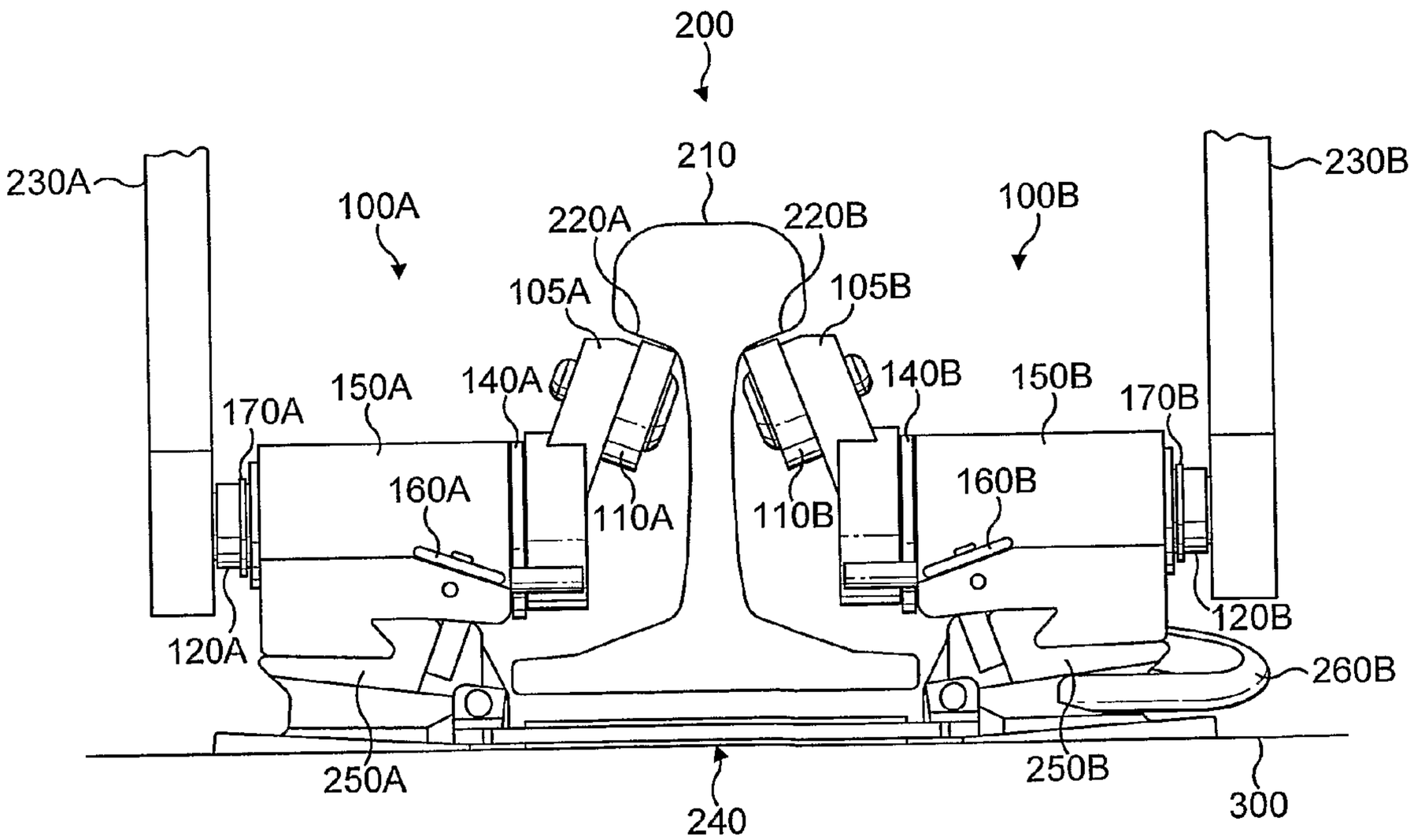

200
210
230A
230B
100A
100B
220A
220B
105A
105B
140A
140B
150A
150B
170A
170B
160A
160B
110A
110B
120A
120B
260B
250A
250B
240
300

FIG. 3

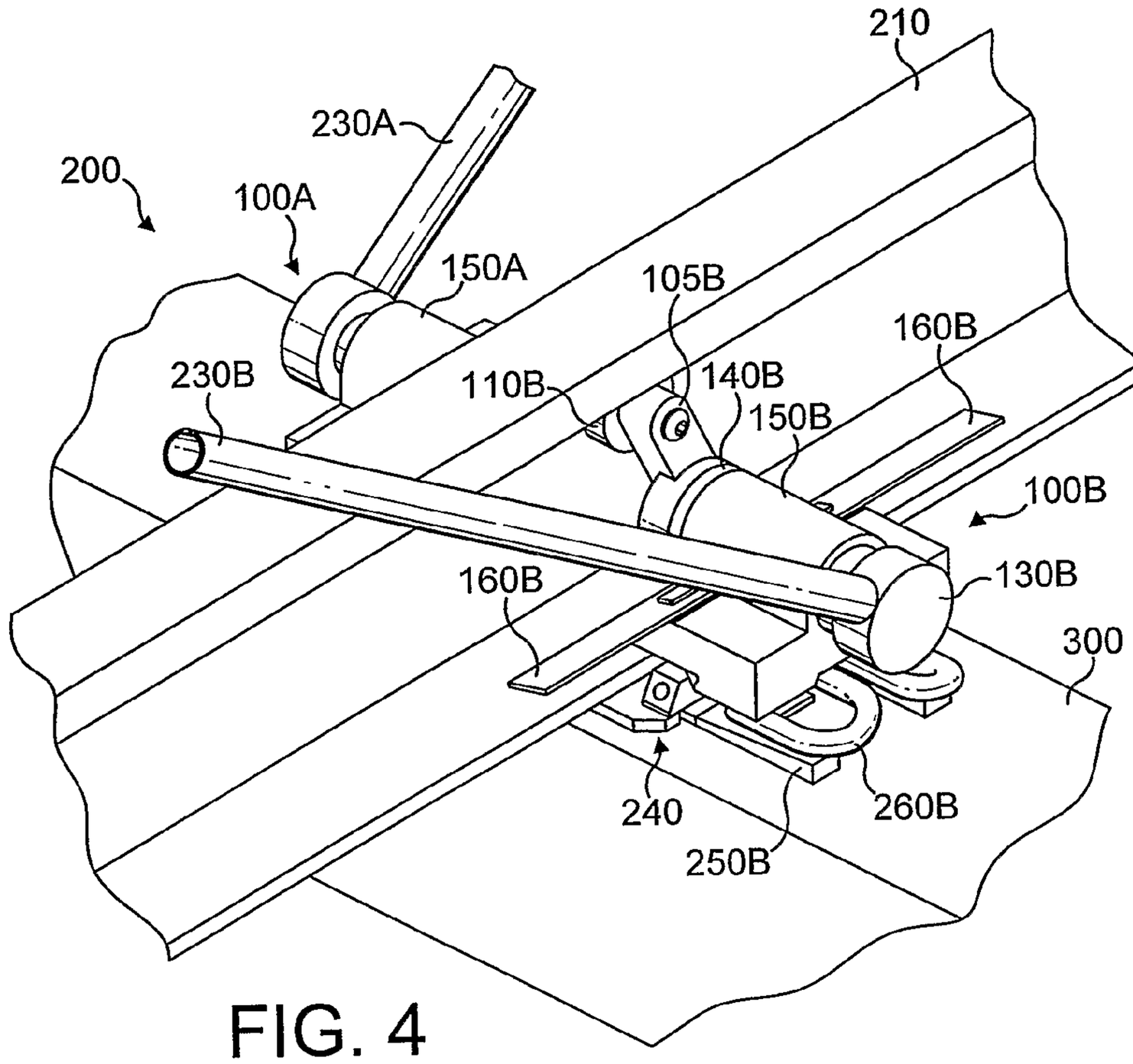

210
230A
200
100A
150A
105B
160B
230B
110B
140B
150B
100B
160B
130B
300
240
260B
250B

FIG. 4

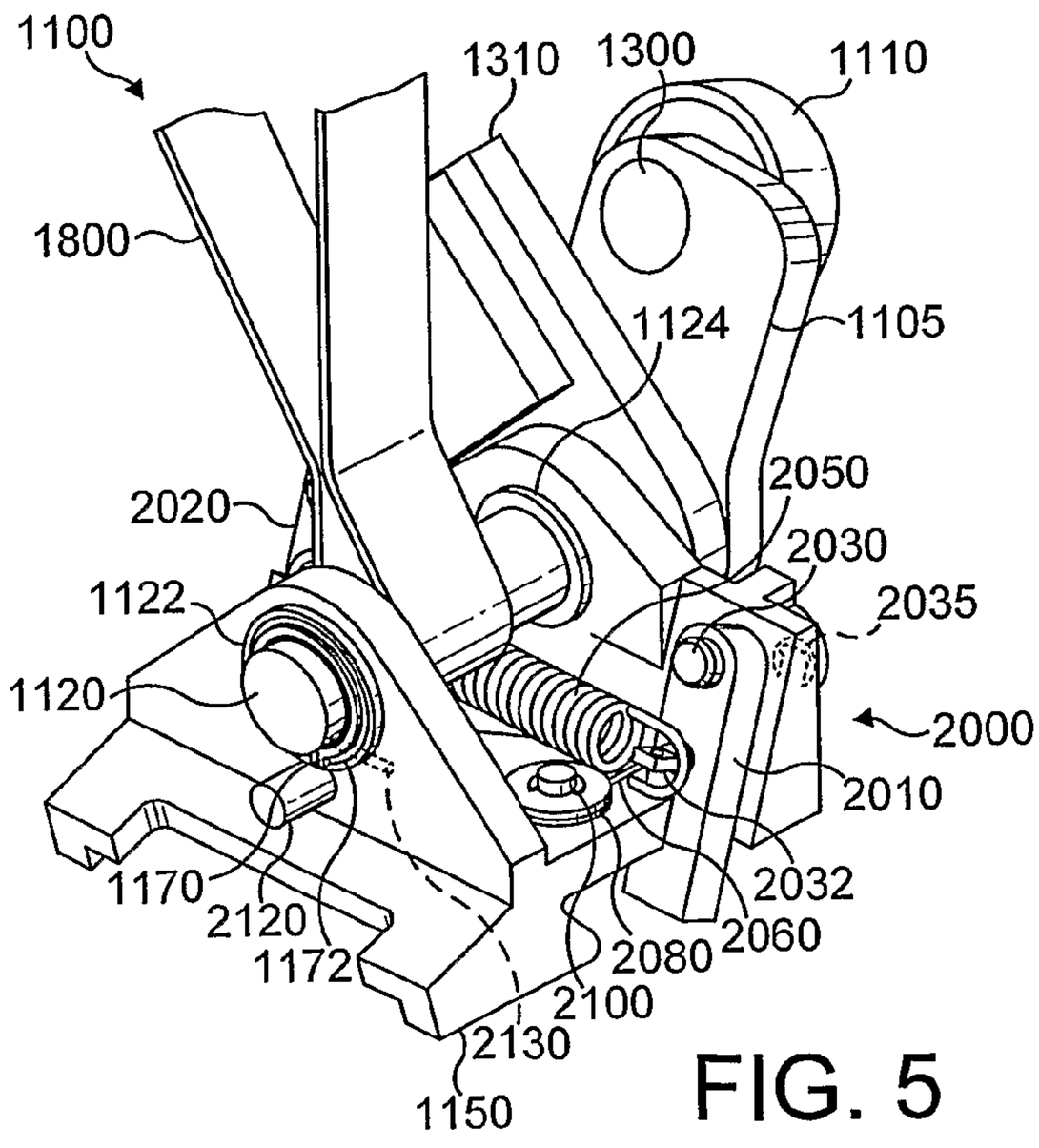

1100
1310
1300
1110
1800
1124
1105
2020
2050
2030
1122
2035
1120
2000
2010
1170
2032
2120
2060
1172
2080
2100
2130
1150

FIG. 5

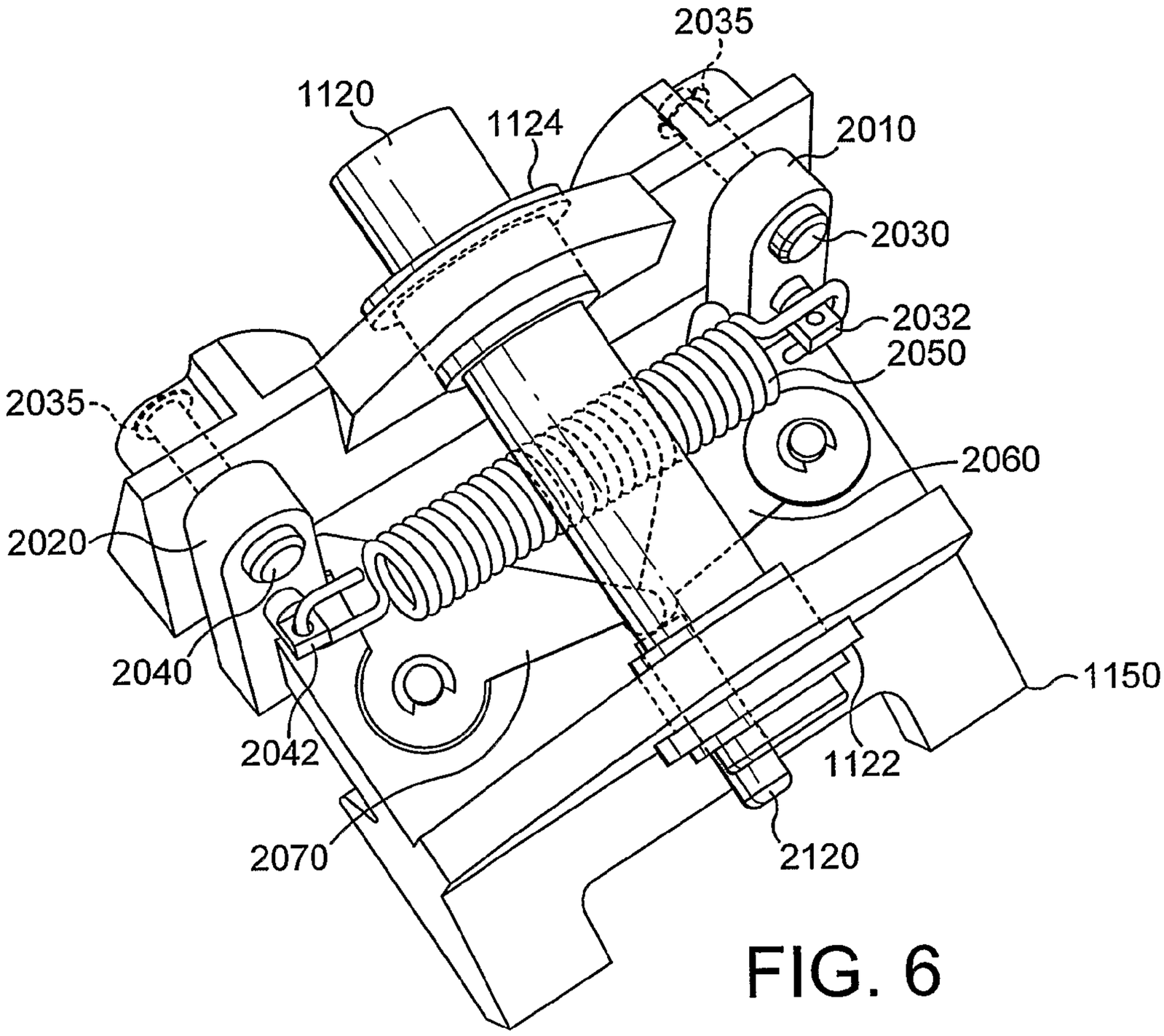

2035
1120
1124
2010
2030
2032
2050
2035
2060
2020
2040
1150
2042
1122
2070
2120

FIG. 6

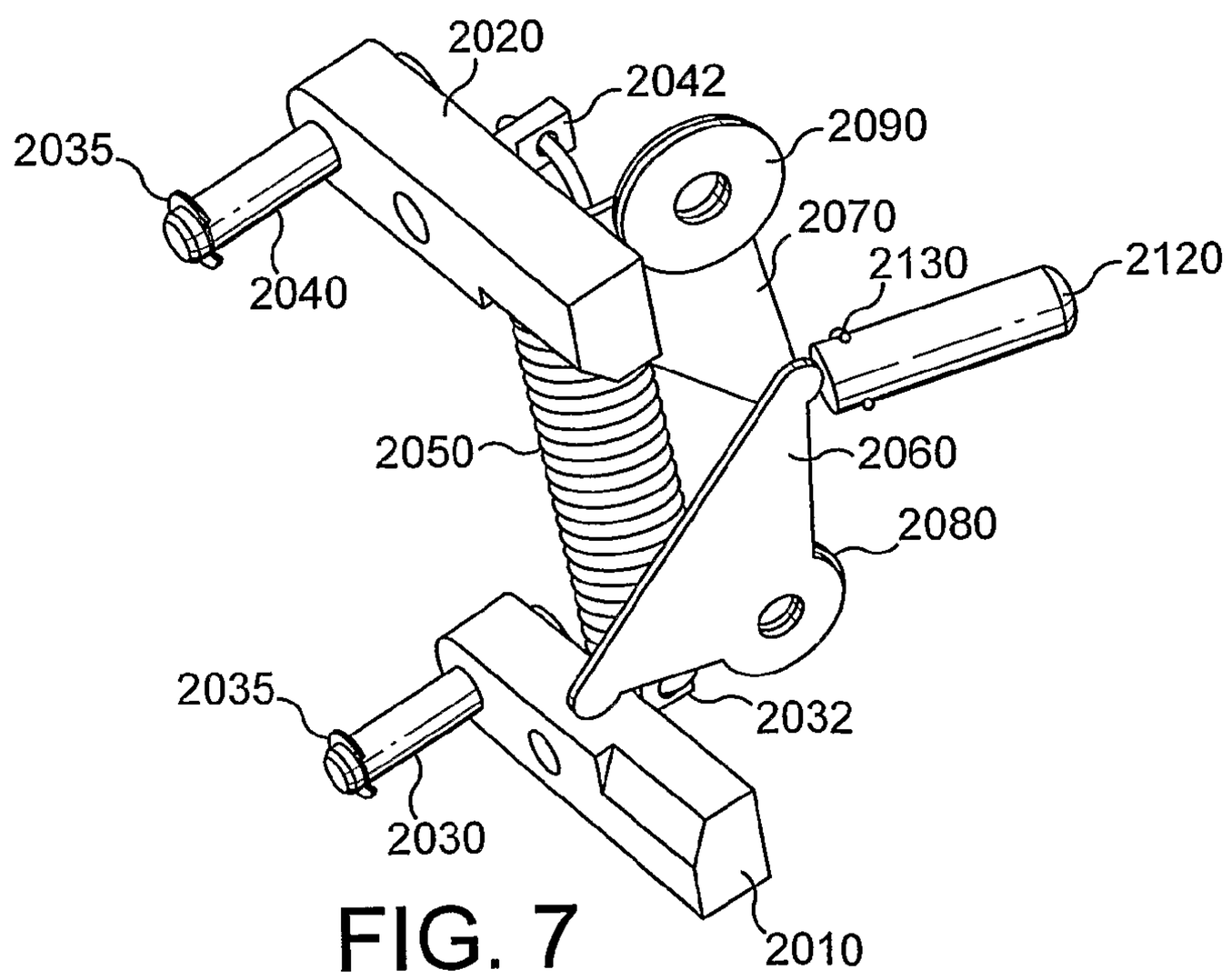

2020
2042
2035
2090
2070
2130
2120
2040
2050
2060
2080
2035
2032
2030
2010

FIG. 7

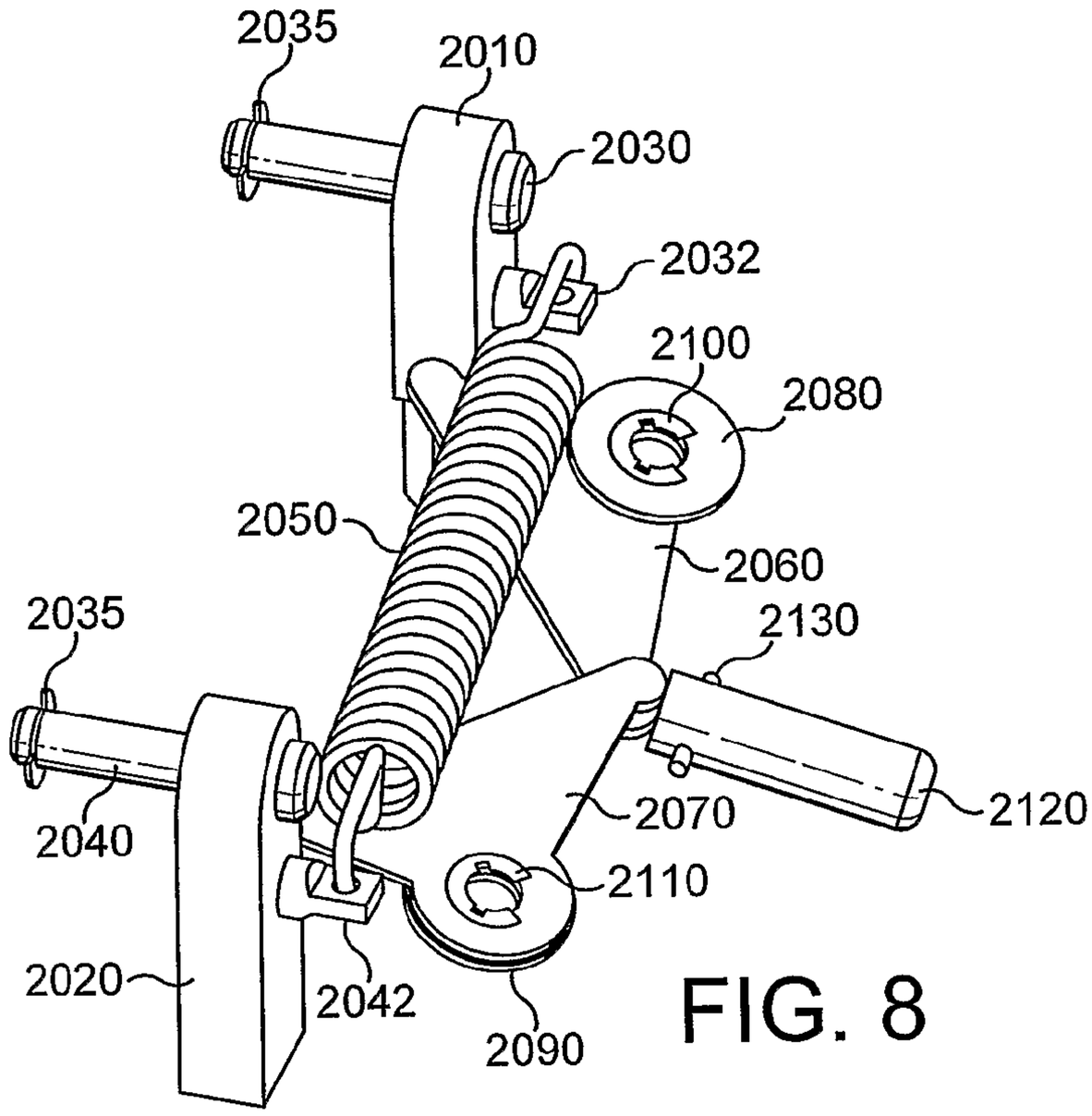

2035
2010
2030
2032
2100
2080
2050
2060
2035
2130
2040
2070
2120
2110
2020
2042
2090

FIG. 8

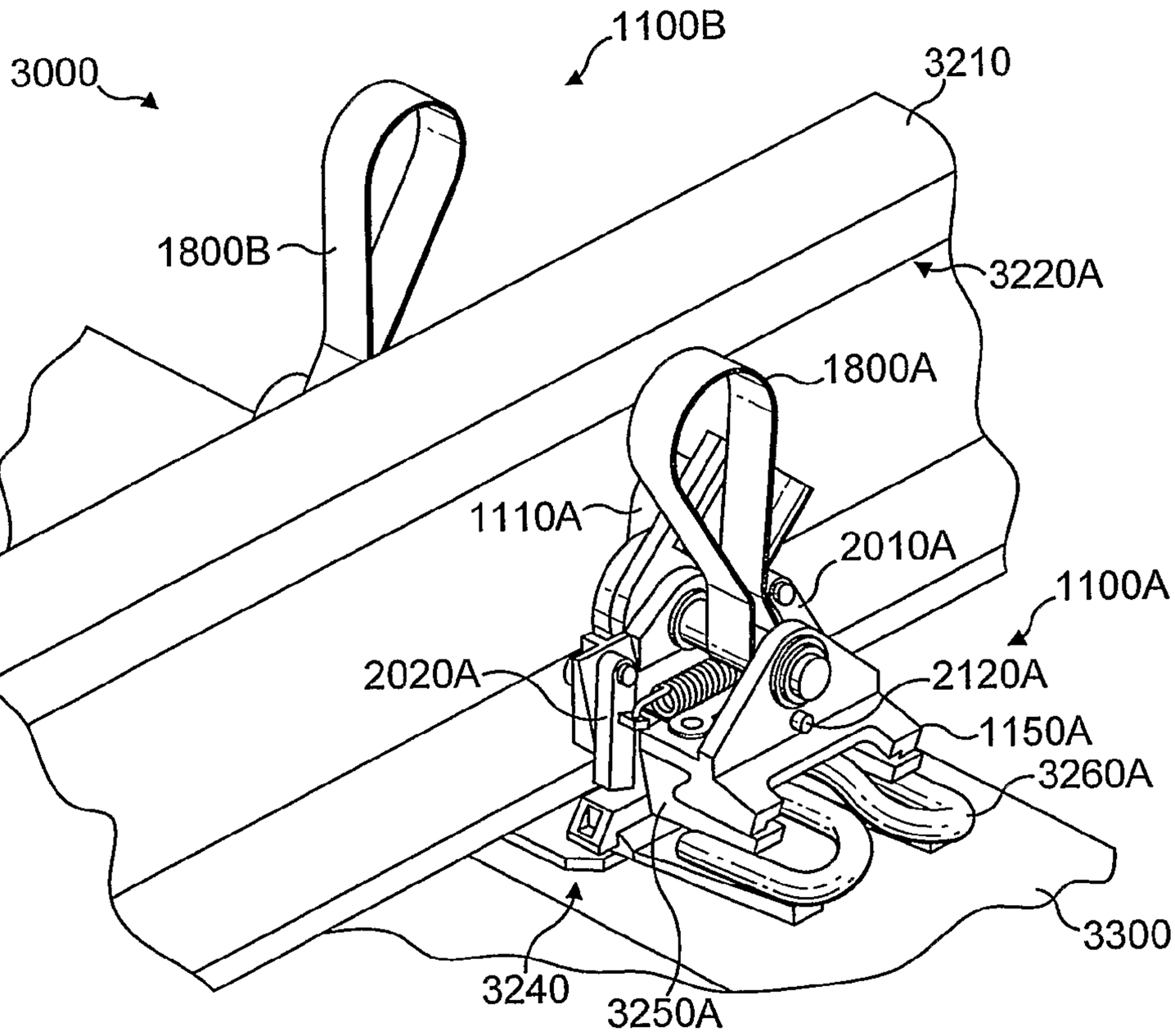

1100B
3000
3210
1800B
3220A
1800A
1110A
2010A
1100A
2020A
2120A
1150A
3260A
3300
3240
3250A

FIG. 9

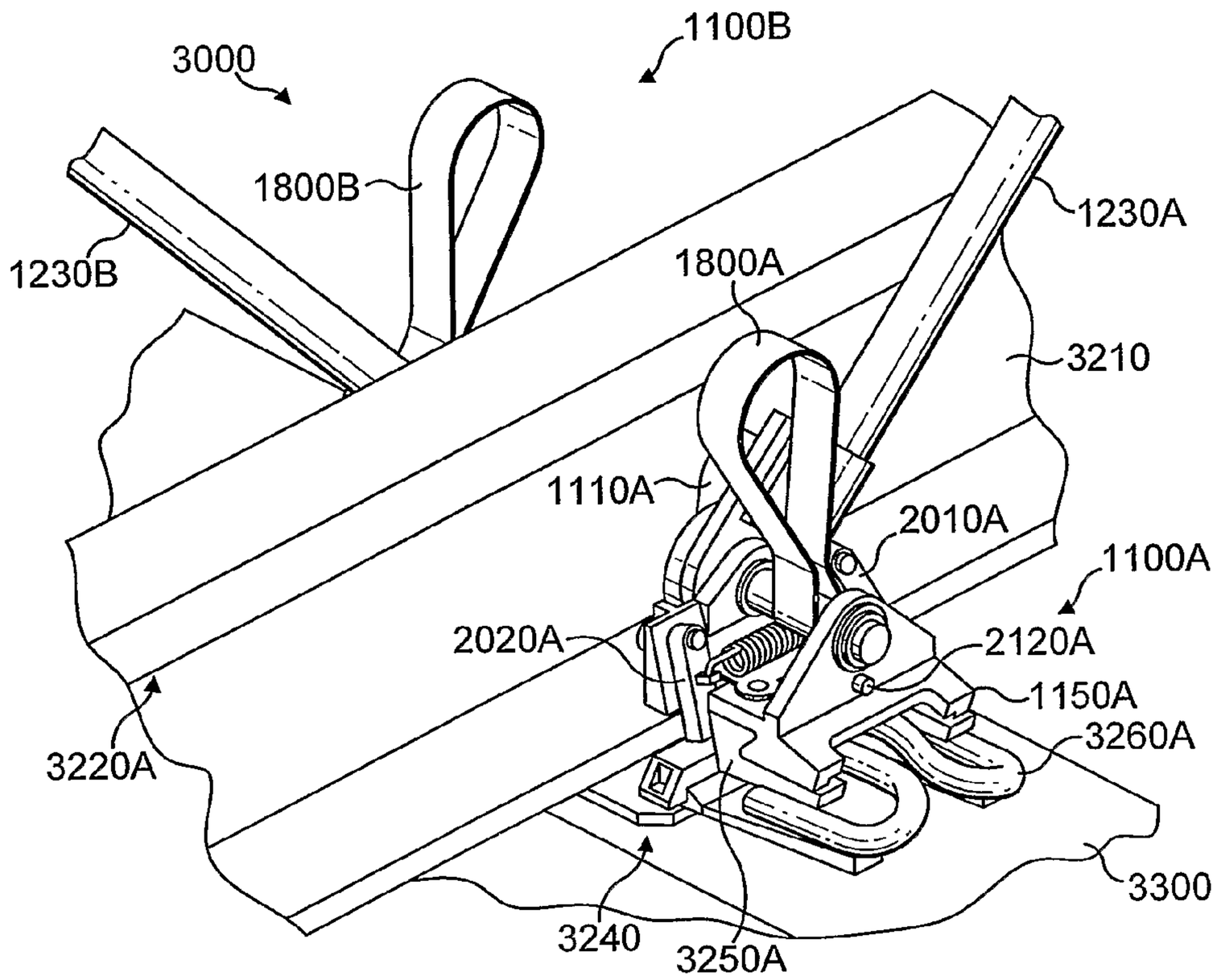
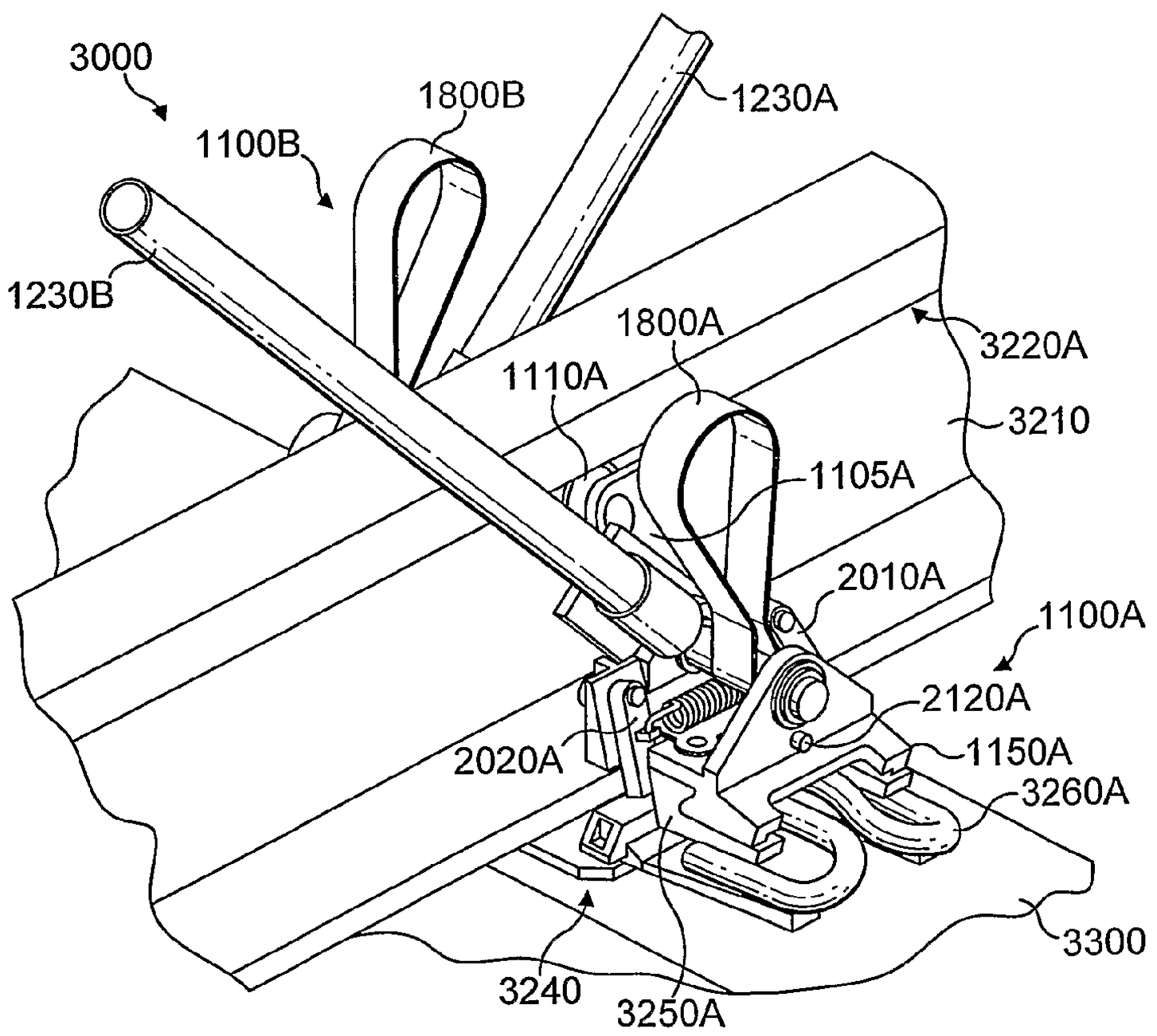

3000
1100B
1800B
1230B
1230A
1800A
3210
1110A
2010A
1100A
2020A
2120A
1150A
3260A
3220A
3300
3240
3250A

FIG. 10


3000
1800B
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1230B
1800A
3220A
1110A
3210
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2010A
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1150A
3260A
3300
3240
3250A

FIG. 11

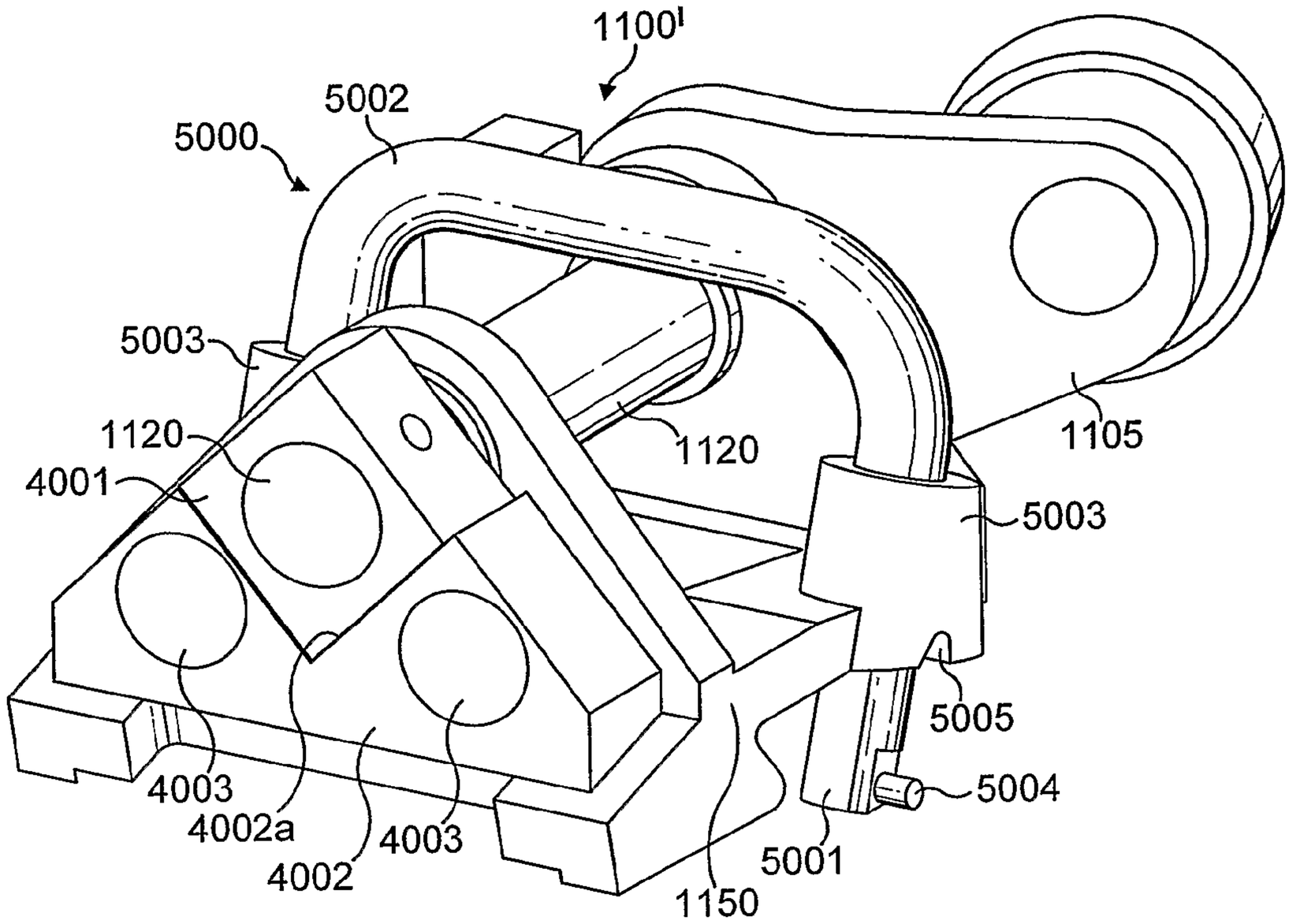

FIG. 12A

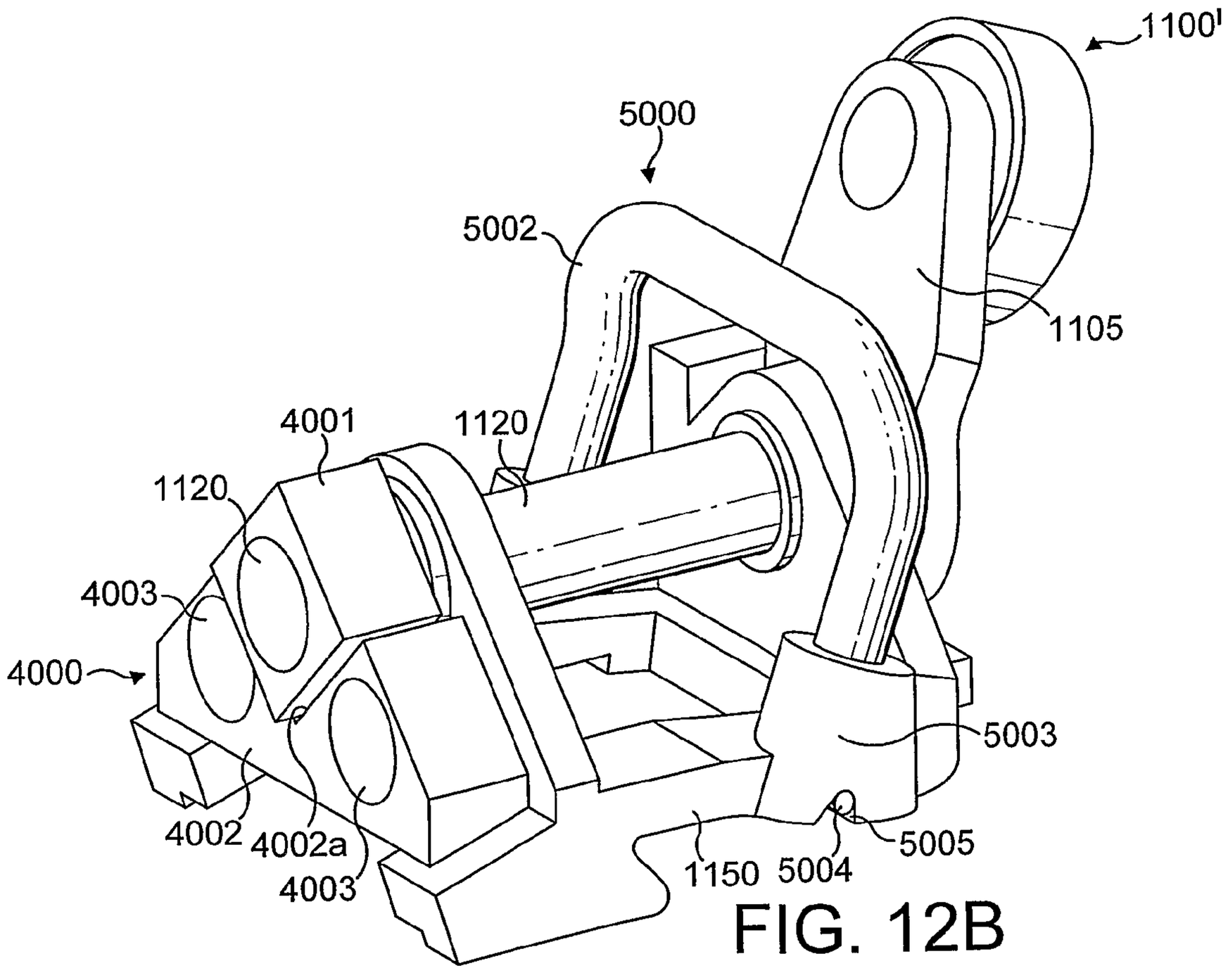

FIG. 12B

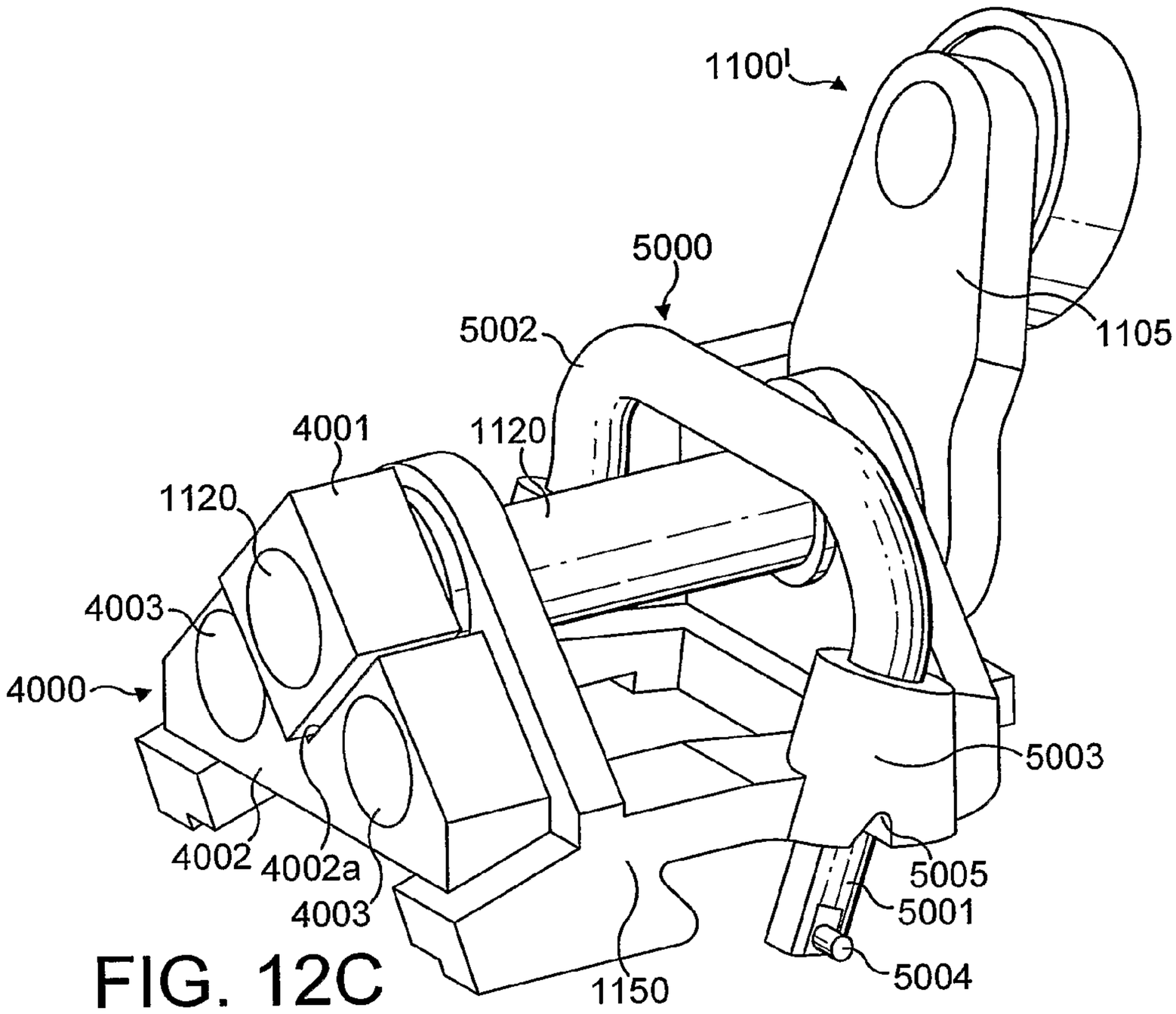

FIG. 12C

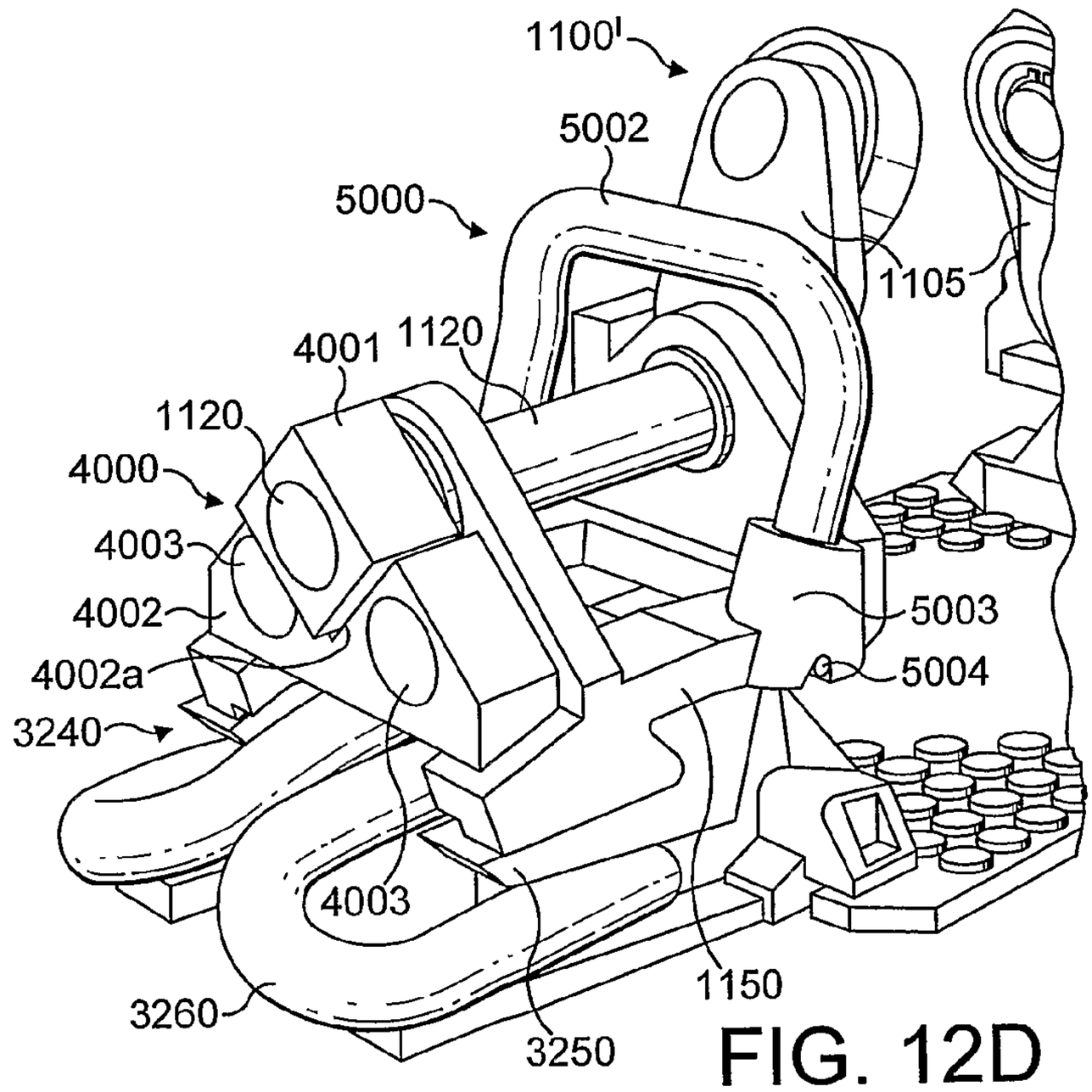

FIG. 12D

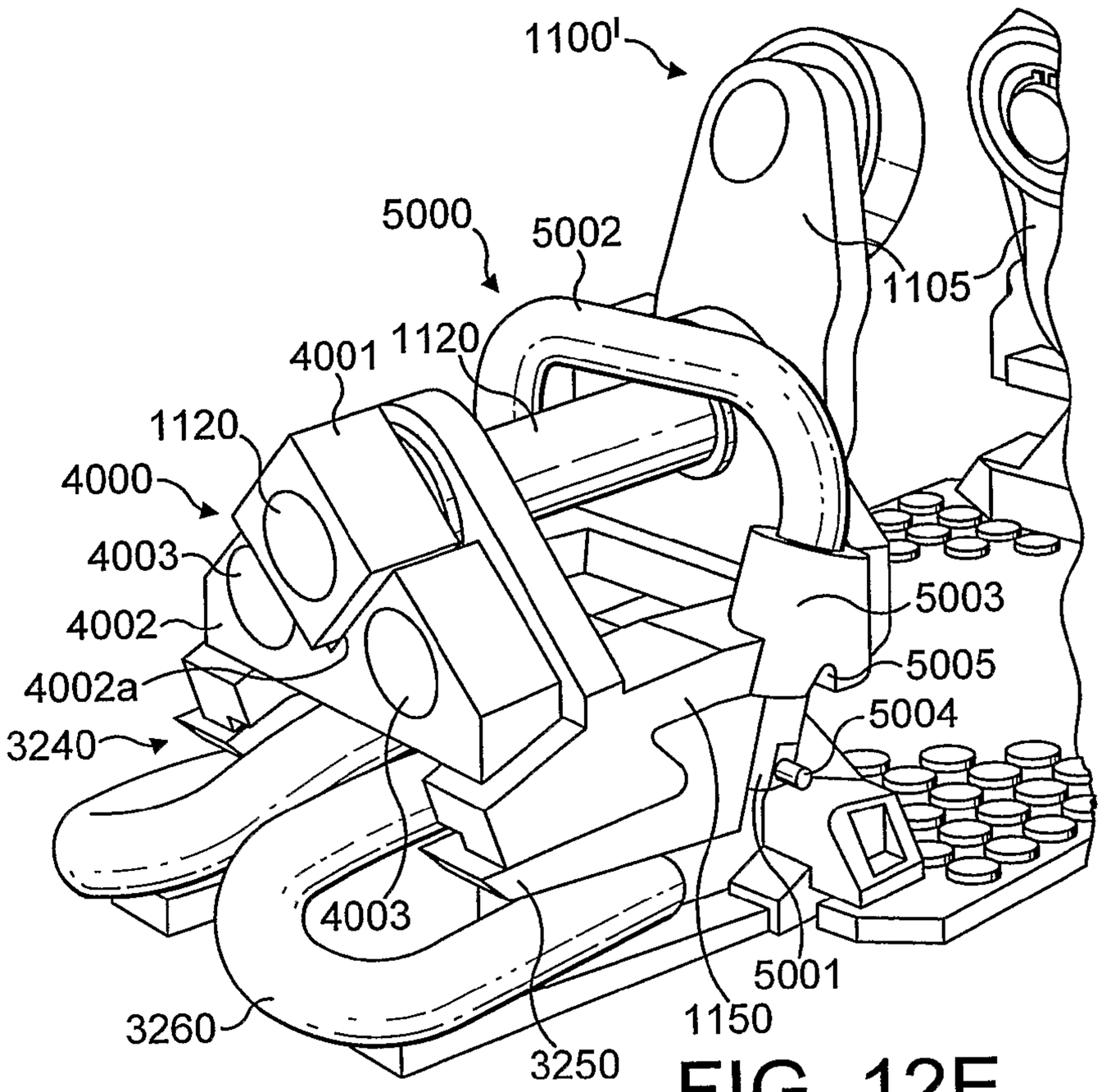

FIG. 12E

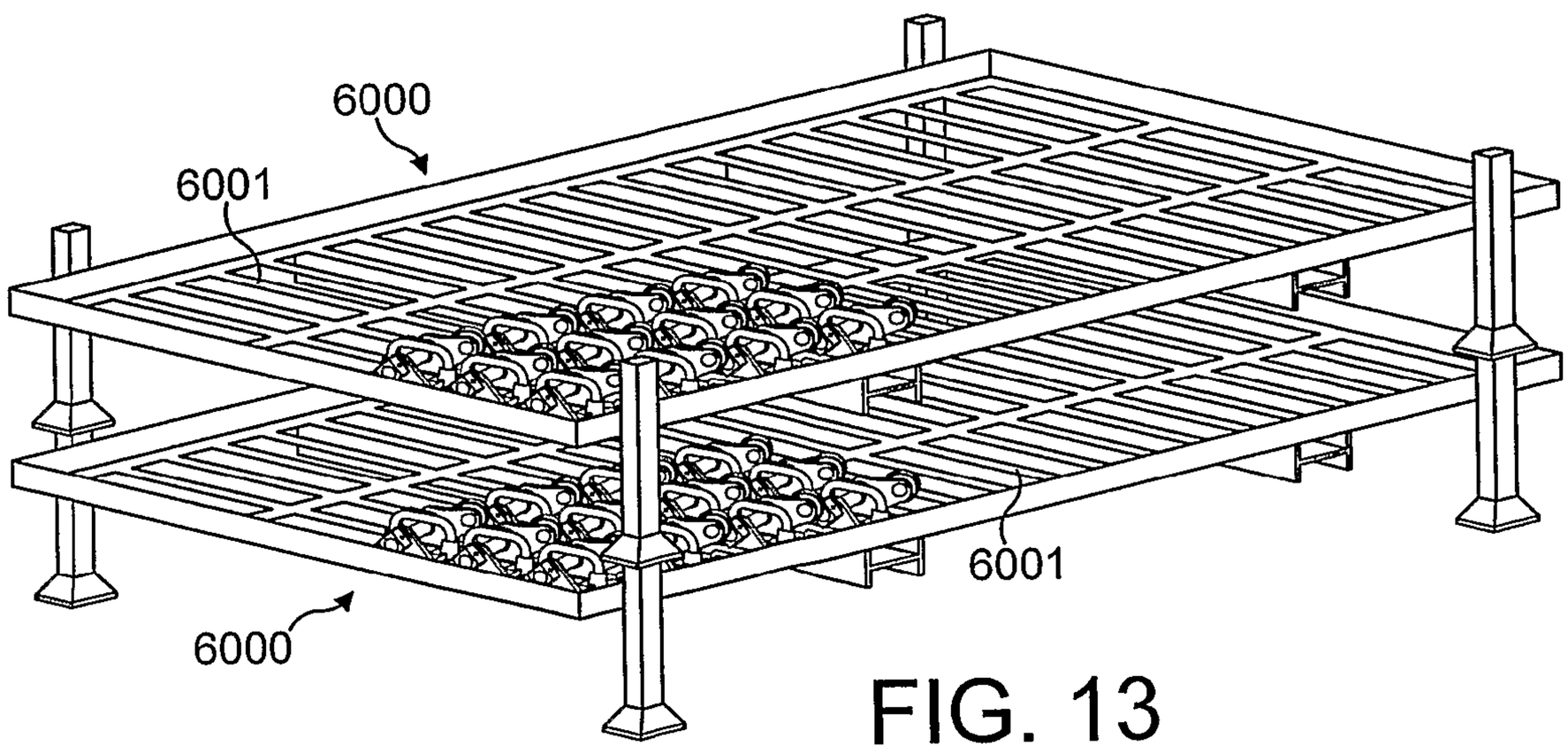

FIG. 13

DEVICE, METHOD AND APPARATUS FOR LIFTING A RAILWAY RAIL

REFERENCE TO RELATED APPLICATIONS

This is the United States National Stage (under 35 U.S.C. §371) of International Patent Application No. PCT/GB2006/002536, filed Jul. 7, 2006, and claims priority to GB 0514907.5, filed Jul. 20, 2005.

FIELD OF THE DISCLOSURE

The present invention relates to a device, method and apparatus for lifting a railway rail.

BACKGROUND

There are different ways of joining railway rails together to form tracks. One such way is to bolt rails together to form jointed track. In this form of track, lengths of rail, usually around 20 meters in length, are laid and fixed into position. In the UK the track lengths are traditionally fixed to sleepers, and in the USA they are traditionally fixed with crossties, or simply ties. Once laid, the track lengths are then joined together with steel plates, known as fishplates or joint bars.

Small gaps are deliberately left between the rails, which are known as expansion joints, to allow for thermal expansion of the rails in hot weather. Additionally, the holes through which the fishplate bolts pass are normally oval to allow for expansion.

Unless well maintained, jointed track provides a characteristic bumpy, noisy and uncomfortable ride due to the presence of the expansion joints, and is unsuitable for high speed trains because it is too weak.

The rail industry commonly uses Continuously Welded Rail (CWR) on all major tracks. In this form of track, the rails are welded together for several kilometers, to form one long continuous rail. This avoids the need for expansion gaps, and because there are few joints the rail is very strong and provides a smooth surface for high speed running. Because of its strength, trains traveling on welded track can travel at higher speeds and with less friction. Welded rails are more expensive to lay than jointed tracks, but are significantly cheaper to maintain.

As mentioned above, rails expand in hot weather (and contract in cold weather). As welded track has very few expansion joints, it could become distorted in hot weather and cause a derailment. In order to compensate for thermal expansion in the welded rail, it is laid with significant tension. This process is commonly known as stressing, and ensures that the rail will not expand much further in subsequent hot weather.

The load applied to the rail to produce the tension is calculated so that, at a locally determined temperature, the rail will expand to reduce the tension to zero. This temperature is known as the stress free temperature (SFT). The SFT varies from country to country, and in the UK is normally 27° C.

FIG. **1**A of the accompanying drawings is a diagram which illustrates a method for tensioning lengths of rail.

Two lengths of rail **10** and **20** are laid upon a number of sleepers. The rail lengths are laid such that a calculated gap **30** exists between the cut ends. The gap is calculated based on the SFT, and the expansion coefficient of the rail. Each length of rail **10**, **20** shown in FIG. **1**A is 900 meters long, however each length of rail can be of any length. The end **40**, **50** of each length of rail **10**, **20** furthest from the gap **30**, is clipped onto the sleepers for a length of more than 20 m. This is known as the anchor length. Tensing machines (normally hydraulic) are

attached to the free ends of the rails **60**, **70** and the rails are pulled towards each other with a force of approximately 60 tons. This force can vary depending on the type of rail and individual site conditions. This tensile force extends the rail lengths **10**, **20** until the free ends **60**, **70** meet. Once the free ends meet, they may be welded together to form a continuous rail length.

FIG. **1**B of the accompanying drawings is a graph illustrating the distribution of rail extension along the unclipped length of a rail in an ideal situation (full line), and in a practical situation (dashed line). Ideally, the extension in the rail length is evenly distributed along the unclipped length. In practice, however, friction between the rail length and the sleeper fittings causes most of the extension to occur close to the tensing point (the initially free end). The consequence of this is to concentrate the load nearest the gap and thus overstress the rail at the weld. This can lead to rail breaks. At the other end, nearest to the anchor, the rail can be unstressed and may buckle in hot weather due to thermal expansion.

In order to reduce these friction effects, existing practice is to use rollers, spaced intermittently along the unclipped length, during the tensing operation. Further, if the track is curved, additional side rollers are employed to keep the rail in the correct position and to resist the tendency for the rail to move towards the center of curvature.

In this existing practice, the rail is lifted by means of jacks, the rollers inserted under the bottom of the rail, and the jacks lowered. Rollers used in the existing practice are simple devices mounted on flat plates. Alternatively, as used in France, the rollers may be lengths of steel bar placed between the rail and the concrete sleeper top.

There are a number of problems with the above-mentioned existing practice.

The use of separate jacks, rollers and side rollers is inconvenient, and as a result the rail stressing process is time-consuming and expensive. Firstly, the use of separate pieces of equipment may necessitate the involvement of several people in order to coordinate the rail-lifting step, the placement of rollers and side rollers, and the rail-lowering step. The lifting of a heavy rail and the placing of rollers thereunder is a hazardous operation for hands that may become trapped.

Although the existing rollers relieve significant friction which would otherwise oppose extension of the rail, they still exert some drag to the free movement of the rail. The existing rollers commonly bear on the underside face of the base (or foot) of the rail. This underside face is normally close to the ground when the rail is in its working position, and is therefore subject to corrosion and may pick up debris. Rolling on this surface is not ideal.

GB 2334692 discloses a railway-rail-lifting tool having a handle at one end, and a system of jaws at the other end. In use, the jaws are placed around the head part of a section of rail, and on lifting of the handle the jaws are caused to grip on the rail for secure lifting. Such a tool requires simple lifting of the rail by hand, and as a result only very small lengths may be lifted for any reasonable length of time. Further, separate rollers and side rollers must be used in conjunction with this rail lifting tool. As above-mentioned, it is inconvenient to have to use separate rollers and side rollers.

U.S. Pat. No. 1,663,061, and GB 1035743 disclose railway-rail-lifting tools incorporating a simple lever mechanism, by which a railway rail may be lifted by hand. Separate rollers and side rollers must be used in conjunction with these rail lifting tools. As above-mentioned, it is inconvenient to have to use separate rollers and side rollers.

WO 01/96663 and FR 2488577 disclose roller clamp apparatuses for use in lifting a railway rail. The apparatuses com-

prise a parallel pair of spaced-apart lift roller assemblies. In the case of WO 01/96663, each roller rotates on an essentially vertical axis. In the case of FR 2488577, each roller rotates on an essentially horizontal axis.

In each case, the roller assemblies are mounted to a support for positioning the pair for clamping to a railway rail. In order to lift the rail, the apparatuses must be connected to a carrier. That is, the apparatuses must be supported by an off track machine such as a crane or gantry. It is considered disadvantageous that such an off track machine be required. Such off track machinery is commonly expensive, requires regular maintenance, may require a large electrical power source, and can be difficult to transport and position securely for use.

SUMMARY OF THE DISCLOSURE

It is desirable to provide a device, method and apparatus which solves the above-mentioned problems. It is further desirable to provide a device capable of lifting a rail and maintaining the rail in a lifted position. It is further desirable to provide a device capable of allowing substantially free extension of a rail under a tensile force, such that a distribution of the extension along the rail approaches the ideal distribution as shown in FIG. **1**B. It is further desirable to provide a single device capable of replacing existing jacks, rollers and side rollers. It is further desirable to provide a device capable of being operated by hand, such that no off track machinery is required. It is further desirable to provide a device capable of lifting a rail from a surface other than the underside face of the rail foot.

According to an embodiment of a first aspect of the present invention, there is provided a railway-rail-lifting device for lifting a railway rail, the device comprising: an arm; and a roller rotatably mounted to the arm; the arm being operable to be rotated to bring the roller to bear on the rail such that the roller exerts a lifting force thereon; characterised by securing means operable to releasably secure the device to a rail fastening assembly. Such a device advantageously renders a separate jack and roller unnecessary. Furthermore, by eliminating the need for a separate jack and roller, the above-mentioned problems and safety hazards associated with coordinating the use of such jacks and rollers are also eliminated. The use of the existing rail fastening assembly to locate the device is advantageous, as it avoids the need to provide other means to which the device may be secured.

The securing means may further be operable to secure the device to a fastener housing portion of the rail fastening assembly, optionally such that the fastener may remain attached to the rail fastening assembly. The securing means may comprise a locking handle, or push button, operable to secure and release the device. Such a locking handle or push button may preferably be operable by hand, such that no additional machinery or tooling is required.

Railway rails generally have a head section and a foot section, the head section having an underside face. Preferably, the arm may be operable to be rotated such that the roller is brought to bear on a portion of said underside face. One advantage of bringing the roller to bear on a portion of the underside face is that that surface generally tends to be clean and free from corrosion and debris, which enables the roller to run freely.

Preferably, the roller is brought into direct contact with the rail. This may advantageously enable a high degree of mechanical efficiency as motion of the extending rail is transferred directly to the roller. Alternatively, however, the roller may have a protective cover, and/or another element placed between the roller and the rail, such that the roller is not brought into direct contact with the rail. This may increase the working life of the roller, the protective cover (and/or the other element) being relatively inexpensive to replace.

Preferably, the roller may be mounted such that a width of the roller's outer face is substantially parallel with the portion of said underside face when the roller is brought to bear thereon. That is, the roller may be mounted at an angle to match the underside surface of the rail when the device is in use. In this way, the surface area of the roller bearing the weight of the rail may be advantageously maximised.

Preferably, the roller is mounted such that its axis of rotation is substantially perpendicular to a longitudinal axis of the rail when the roller is brought to bear on the rail. It is advantageous that those axes are perpendicular, because an uppermost portion of the outer surface of the roller will thereby move in substantially the same direction as the rail when it is extended longitudinally. Thus, any slippage between the outer surface of the roller and the rail which would cause mechanical loss through friction is minimised. Further, by allowing a relatively free motion of the rail in the direction of extension, it is possible that a distribution of the extension along the rail length may approach the ideal distribution as shown in FIG. **1**B.

Preferably, the roller may be operable, when exerting a lifting force on the rail, to exert a position-maintaining force on the rail so as to resist a movement of the rail. In this way, motion of a curved rail length towards the center of curvature may be resisted without the need for additional side rollers.

The device may further comprise transmitting means operable to transmit a force to the arm so as to rotate the arm. In this way, it is possible to avoid the need for additional transmitting means. The transmitting means may, optionally, comprise a shaft coupled to the arm. The shaft may preferably be mounted in at least one axial bearing, and/or with at least one thrust bearing. Such an axial bearing may enable substantially low friction rotation of the shaft about its axis, and may also enable substantially low friction motion of the shaft along its axis. Such a thrust bearing may limit motion of the shaft along its axis. Since the roller is mounted to the arm, and the arm may be optionally coupled to the shaft, such a thrust bearing may thereby enable the roller to exert the above-mentioned position-maintaining force.

Preferably, the transmitting means of the device may further comprise a handle or lever temporarily attachable to the shaft. Further, such a handle or lever may be configured such that a force applied to the handle or lever by hand generates a lifting force. By enabling the rail to be lifted by hand, additional off track machinery may be advantageously avoided.

Optionally, the device may comprise a motor coupled to the transmitting means and operable to generate the rotating force necessary for the roller to lift the arm. The motor may be permanently coupled to the transmitting means or detachably coupled thereto, such that one motor may be used with several devices. The use of an electrical motor may advantageously limit the amount of energy required by an operator of the device.

The roller of the device may be a bearing, and preferably a precision bearing. Such a bearing may advantageously provide a lifting surface which is capable of rotating under low friction conditions.

The device may further comprise rotation limiting means operable to limit the rotation of the arm. The rotation means may comprise a member located across a path of rotation of the arm, so as to limit that path. The rotation means may, for example, limit the path of motion of the arm from a horizontal position through an angle of rotation θ. The angle of rotation θ is preferably greater than 90 degrees, and may optionally be

equal to 100 degrees. It is advantageous that the angle θ be greater than 90 degrees, such that the arm may be brought through an upwardly vertical position during lifting. In this way, the weight of the rail bearing on the roller may keep the arm in the lifted position. That is, preferably a further lifting force must be exerted on the rail to rotate the arm back through the vertical position to subsequently lower the rail. An additional lock may be employed to prevent rotation of the arm.

According to an embodiment of a second aspect of the present invention, there is provided a railway-rail-lifting method for lifting a railway rail, the method comprising: rotating the arm of a device embodying the aforementioned first aspect of the present invention to bring the roller to bear on the rail such that the roller exerts a lifting force thereon.

According to an embodiment of a third aspect of the present invention, there is provided railway-rail-lifting apparatus for lifting a railway rail, the apparatus comprising two of said devices embodying the aforementioned first aspect of the present invention, wherein the rail has first and second underside faces on opposite sides of the rail, and wherein the arm of a first one of the said devices is operable to be rotated such that the roller of the first device is brought to bear on a portion of said first underside face, and wherein the arm of a second one of the said devices is operable to be rotated such that the roller of the second device is brought to bear on a portion of the second underside face.

Preferably, the first and second devices are operable to exert their respective first and second lifting forces simultaneously. In that case, and assuming that no other lifting force is exerted on the rail, the sum of said first and second lifting forces need only be at least equal to a force required to lift the rail.

Advantageously, a number of apparatuses according to the aforementioned third aspect of the present invention may be used simultaneously at various locations along a rail. In that case, the sum of lifting forces of all the apparatuses need only be at least equal to a force required to lift the rail. In this way, the lifting and lowering process may be safe and well controlled since the rail is supported in a number of locations therealong.

It is advantageous to use first and second devices on opposite sides of the rail in order to stabilise the rail on lifting, and prevent lateral movement of the rail. In this way, it may be possible to ensure that the rail is positioned centrally with respect to the rail fastening assembly throughout extension of the rail, in order to facilitate reattachment of the rail to the rail fastening assembly after the tensioning is complete. Such lateral movement may be movement towards or away from a center of curvature in the case of a curved rail section.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

Reference will now be made, by means of example, to the accompanying drawings, in which:

FIG. **1**A (described above) is a diagram which illustrates a method for tensioning lengths of rail.

FIG. **1**B (described above) is a graph illustrating the distribution of rail extension along the unclipped length of a rail in an ideal situation, and in a practical situation.

FIG. **2** is a perspective view of a device according a first embodiment of the present invention.

FIG. **3** is a cross-sectional view of apparatus according to a second embodiment of the present invention in use.

FIG. **4** is a perspective view of the second embodiment of the present invention in use.

FIG. **5** is a perspective view of a third embodiment of the present invention.

FIG. **6** is a partly ghosted view of a portion of the third embodiment of the invention.

FIGS. **7** and **8** are two different perspective views of the securing means of the third embodiment of the invention.

FIGS. **9** to **11** are three views of apparatus according to a fourth embodiment of the present invention in use.

FIGS. **12**A to **12**E show a fifth embodiment of the present invention.

FIG. **13** shows pallets onto which embodiments of the present invention may be loaded for transportation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **2** of the accompanying drawings shows a device **100** according to a first embodiment of the present invention. Device **100** comprises a lift arm **105**, a roller comprising a bearing **110**, a shaft **120**, a spacer **140**, a mount assembly **150**, two locking handles **160**, and a circlip **170**.

The bearing **110** is rotatably mounted at a predetermined angle to one end of the arm **105**. The arm **105** is coupled at its other end to one end of the shaft **120**. The shaft is substantially housed within the mount assembly **150**, preferably in at least one axial bearing (not shown), and/or with at least one thrust bearing (not shown).

Spacer **140** is located between the arm **105** and the mount assembly **150**, so as to maintain a minimum distance between the arm **105** and the mount assembly. It is envisaged that spacer **140** is an optional component of device **100**. Circlip **170** is located on a portion of the shaft **120** protruding out of the mount assembly **150** away from the arm **105**. The shaft **120** is free to move axially within the mount assembly **150**, but the travel is limited, in this case to 6 mm, by means of either the arm **105** abutting a thrust bearing (or thrust washer) via the optional spacer **140**, or the circlip **170** abutting a thrust bearing (or thrust washer).

An end portion **130** of the shaft **120**, opposite to the end of the shaft coupled to the arm **105**, has a square cross-section. A lever or handle (not shown) having a complementary attachment portion, for example a matching square hole, may be temporarily attached thereto. The end portion **130** may have any cross-section providing that the end portion and its lever or handle have complementary attachment means for connecting them together.

The mount assembly **150** forms the main body of the device **100**, providing support for the shaft **120** and the arm **105**. Locking handles **160**, coupled to the mount assembly **150**, form part of securing means operable to secure the device **100** in a fixed position. Such securing means are partly housed within the mount assembly **150**. Locking handles **160** are operable to secure the device **100** to a rail fastening system (not shown in FIG. **2**), in particular the PANDROL FASTCLIP™ housing, such that the device may withstand high loads associated with rail lifting. Mount assembly **150** is designed such that a fastener of the rail fastening system may remain within the fastener housing portion in the withdrawn position. Although mount assembly **150** is designed to fit a PANDROL FASTCLIP™ rail fastening system, it could also be designed to fit another type of rail fastening system, such as a system employing a PANDROL "e"-CLIP™ type of fastener, or to be generic to many types of rail fastening system. Although the device **100** has two locking handles **160**, it is envisaged that another embodiment of the present invention could comprise only one locking handle, or alternatively securing means not having any locking handles.

A stop pin (not shown) is provided in the mount assembly **150**, which may engage with a feature in the arm **105** to prevent rotation of the arm **105** past a predetermined position. The stop pin of device **100** is positioned so as to allow the arm **105** to rotate from a horizontal position through an angle of 100 degrees to a position 10 degrees past an upwardly vertical position.

In use, after a rail has been detached from a Pandrol FASTCLIP™ rail fastening system, device **100** is secured to a fastener housing portion thereof using the securing means and locking handles **160**. A lever or handle is attached to end **130** of the shaft **120**. The lever or handle is rotated to rotate the arm **105** from a substantially horizontal position towards an upwardly vertical position such that the bearing **110** is brought into direct contact with an underside face of the head portion of the rail. The predetermined angle at which the bearing is mounted to the arm **105** is set such that the portion of the outer surface of the bearing brought into contact with the underside face of the rail is substantially parallel thereto. The lever or handle is further rotated, lifting the rail, until a feature of the arm **105** engages with the stop pin, such that no further rotation is permitted. In this position, the lever or handle may be removed from the device **100** or left in position, the weight of the rail maintaining the position of the arm **105** relative to the stop pin. An additional or alternative lock may be used to maintain the position of the arm **105**.

In the lifted position, any longitudinal movement of the rail, for example extension of the rail as a result of any tensile force applied thereto, will cause the bearing **110** to rotate. Advantageously, due to the low friction rotation properties of the bearing **110**, the rail may move longitudinally in the lifted position substantially freely. Conversely, any lateral movement of the rail towards the bearing **110**, for example towards a center of curvature in the case of a curved section of rail, will be resisted since the device **100** is securely fixed to the rail fastening assembly. Advantageously, lateral movement of the rail towards device **100** is substantially prevented, maintaining the lateral position of the rail such that it may be lowered into a position for refastening to the rail fastening assembly.

The rail is lowered by reattaching (if necessary) the lever or handle to the shaft **120** and rotating it to rotate the arm back through the upwardly vertical position back to the horizontal position, such that the rail is brought to rest with the bearing not directly contacting the rail. In this position, locking handles **160** are used to release device **100** from the rail fastening assembly. The rail may then be refastened to the rail fastening assembly.

Although a lever or handle is used to provide the force necessary to rotate arm **105** for lifting and lowering, it is envisaged that a motor permanently or temporarily attached to the shaft **120** could be used to provide the necessary force.

FIG. **3** of the accompanying drawings is a cross-sectional view of apparatus **200** according to a second embodiment of the present invention in use. FIG. **4** of the accompanying drawings is a perspective view of the second embodiment of the present invention in use.

Apparatus **200** comprises two devices **100**A and **100**B, each substantially identical to the aforementioned device **100**. In addition to apparatus **200**, FIG. **3** shows a rail **210**, two levers **230**A and **230**B, and a rail fastening assembly **240** which rests upon a sleeper **300**.

Those parts of devices **100**A and **100**B already described with reference to device **100** of FIG. **2** have been numbered in the same way, but with additional respective suffixes A and B. Accordingly, unnecessary duplicate description of those parts is omitted.

Devices **100**A and **100**B are shown maintaining the rail **210** in the lifted position. Device **100**A is secured to one rail fastener housing **250**A of the rail fastening assembly **240**. Similarly, device **100**B is secured to the other rail fastener housing **250**B of the rail fastening assembly **240**. A rail fastener **260**B remains within rail fastener housing **250**B in a withdrawn position. Another rail fastener (not shown) could remain within rail fastener housing **250**A in a withdrawn position.

Levers **230**A and **230**B are located on shafts **120**A and **120**B, respectively. Bearings **110**A and **110**B are in direct contact with underside faces **220**A and **220**B of the head section of the rail **210**. Underside faces **220**A and **220**B are clean blemish-free surfaces on which bearings **110**A and **110**B can run.

Spacers **140**A and **140**B ensure that lift arms **105**A and **105**B are distanced from mount assemblies **150**A and **150**B, such that rail **210** is held centrally between rail fastener housings **250**A and **250**B. That is, apparatus **200** ensures that no substantial lateral movement of rail **210** is permitted. No additional side rollers are required.

In use, levers **230**A and **230**B are rotated simultaneously to ensure balanced lifting and lowering of the rail **210**. The mechanical advantage afforded by levers **230**A and **230**B enables rail **210** to be lifted by hand.

FIG. **5** of the accompanying drawings shows a device **1100** according to a third embodiment of the present invention. Device **1100** comprises a lift arm **1105**, a roller comprising a bearing **1110**, a bearing shaft **1300**, a shaft **1120**, a handle stub **1310**, two bearings **1122** and **1124**, a circlip **1170**, a washer **1172**, a mount assembly **1150**, a carrying strap **1800**, and securing means **2000**.

Securing means **2000** comprises two locking fingers **2010** and **2020**, two finger pins **2030** and **2040** (not shown), two finger spring pins **2032** and **2042** (not shown), a finger spring **2050**, two bell cranks **2060** and **2070** (not shown), two washers **2080** and **2090** (not shown), two finger circlips **2100** and **2110** (not shown), push button **2120**, and roll pin **2130**.

The bearing **1110** is rotatably mounted onto bearing shaft **1300**, which is itself mounted to one end of the arm **1105** such that bearing **1110** is mounted at a predetermined angle relative to the arm **1105**. The arm **1105** is coupled at its other end to one end of the shaft **1120**. The shaft is supported within the two bearings **1122** and **1124** such that it can rotate about its axis. Bearings **1122** and **1124** are located partially within the mount assembly **1150**.

Circlip **1170** and washer **1172** are located on a portion of the shaft **1120** protruding out of the bearing **1122** away from the arm **1105**. The shaft **1120** is free to move axially within the bearings **1122** and **1124**, but its freedom of travel longitudinally towards the arm **1105** is limited by the presence of the washer **1172** and circlip **1170**.

Handle stub **1310** is coupled to the shaft **1120** adjacent to the lift arm **1105**. A lever or handle (not shown), having an attachment portion suitable for attachment to the handle stub **1310**, may be temporarily attached thereto.

The mount assembly **1150** forms the main body of the device **1100**, providing support for the shaft **1120** and the arm **1105**. Securing means **2000** is mounted on, and partially within, mount assembly **1150**. Securing means **2000** is operable to secure the device **1100** in a fixed position onto a rail fastening system, in particular to the housing of a PANDROL FASTCLIP™ rail fastening system, such that the device may withstand high loads associated with rail lifting. Mount assembly **1150** is designed such that a fastener of the rail fastening system may remain within the fastener housing portion in the withdrawn position. Although mount assembly

1150 is designed to fit a PANDROL FASTCLIP™ rail fastening system, it could also be designed to fit another type of rail fastening system, such as a system employing a PANDROL "e"-CLIP™ type of fastener, or to be generic to many types of rail fastening system.

Carrying strap **1800** is loosely attached to the shaft **1120** between the bearings **1122** and **1124**. Carrying strap **1800** is made of nylon, although it could be made of another material, such as leather. Carrying strap **1800** is sufficiently strong enough to support the weight of device **1100**. A typical weight of device **1100** is 3 kg. Accordingly, device **1100** is portable.

A stop pin (not shown) may be optionally provided in the mount assembly **1150**, which may engage with a feature in the arm **1105** to prevent rotation of the arm **1105** past a predetermined position. Such a stop pin may be positioned so as to allow the arm **1015** to rotate from a horizontal position through an angle of 100 degrees to a position 10 degrees past an upwardly vertical position.

The two locking fingers **2010** and **2020**, of securing means **2000**, are rotatably mounted to the mount assembly **1150** via the two finger pins **2030** and **2040**. Each said finger pin is retained in its mounted position by a circlip **2035**. The two locking fingers **2010** and **2020** extend downwardly from the two finger pins **2030** and **2040**, and can rotate relative to the mount assembly **1150** in a plane substantially orthogonal to the axis of shaft **1120**. The two locking fingers **2010** and **2020** have finger spring pins **2032** and **2042** mounted thereto, respectively. Finger spring **2050** is attached at one end to finger spring pin **2032**, and at the other end to finger spring pin **2042**. Finger spring **2050** spring biases locking fingers **2010** and **2020** into a locked position in which they are rotated towards one another. When device **1100** is in its working disposition, for example located on a PANDROL FASTCLIP™ rail fastening housing, locking fingers **2010** and **2020** are spring biased into the locked position, which locks device **1100** to the housing of the rail fastening system.

Bell cranks **2060** and **2070** are rotatably mounted onto mount assembly **1150**, and are secured into place with washers **2080** and **2090**, and finger circlips **2100** and **2110**. Bell cranks **2060** and **2070** are operable to rotate such that they engage with locking fingers **2010** and **2020**, respectively, such that they cause locking fingers **2010** and **2020** to rotate away from one another into an unlocked position. As above-mentioned, however, the finger spring **2050** biases locking fingers **2010** and **2020** into the locked position. Accordingly, in the absence of an unlocking force applied to bell cranks **2060** and **2070**, locking fingers **2010** and **2020** remain in the locked position.

Push button **2120** is located within a hole formed in mount assembly **1150**. Roll pin **2130** is mounted partially within push button **2120**, such that its ends protrude out of the sides thereof. Roll pin **2130** may guide the passage of the push button **2120** through the hole, and/or prevent push button **2120** from inadvertently falling out of the hole. To release device **1100** from its working disposition, push button **2120** may be pushed so that it engages with bell cranks **2060** and **2070**, and causes them to rotate so as to push locking fingers **2010** and **2020** away from one another into the unlocked position.

Push button **2120**, when pushed, engages with both bell cranks **2060** and **2070** together. Accordingly, if either of the locking fingers is stuck into the locked position, for example due to a fault in either of the bell cranks (or in either of the locking fingers), the device **1100** will remain locked, and a user will be alerted to the presence of such a fault.

In use, after a rail (not shown) has been detached from the rail fastening system, device **1100** is secured to a fastener housing portion thereof using the securing means **2000**. A lever or handle (not shown) is attached to the handle stub **1310**. The lever or handle is rotated to rotate the arm **1105** from a substantially horizontal position towards an upwardly vertical position such that the bearing **1110** is brought into direct contact with an underside face of the head portion of the rail. The predetermined angle at which the bearing **1110** is mounted relative to the arm **1105** is set such that the portion of the outer surface of the bearing brought into contact with the underside face of the rail is substantially parallel thereto. The lever or handle is further rotated, lifting the rail, until a feature of the arm **1105** engages with the stop pin, such that no further rotation is permitted. In this position, the lever or handle may be removed from the handle stub **1310** or left in position, the weight of the rail maintaining the position of the arm **1105** relative to the stop pin. An additional or alternative lock may be used to maintain the position of the arm **1105**.

In the lifted position, any longitudinal movement of the rail, for example an extension of the rail as a result of any tensile force applied thereto, will cause the bearing **1110** to rotate. Advantageously, due to the low friction rotation properties of the bearing **1110**, the rail may move longitudinally in the lifted position substantially freely. Conversely, any lateral movement of the rail towards the bearing **1110**, for example towards a center of curvature in the case of a curved section of rail, will be resisted since the device **1100** is securely fixed to the rail fastening assembly. Advantageously, lateral movement of the rail towards device **1100** is substantially prevented, maintaining the lateral position of the rail such that it may be lowered into a position for refastening to the rail fastening assembly.

The rail is lowered by reattaching (if necessary) the lever or handle to the handle stub **1310** and rotating it to rotate the arm back through the upwardly vertical position back to the horizontal position, such that the rail is brought to rest with the bearing not directly contacting the rail. In this position, push button **2120** is used to release device **1100** from the rail fastening assembly. The rail may then be refastened to the rail fastening assembly. In one embodiment of the invention, the rail may be refastened to the rail fastening assembly before the device (e.g. device **1100**) is released from the rail fastening housing.

Although a lever or handle is used to provide the force necessary to rotate arm **1105** for lifting and lowering, it is envisaged that a motor permanently or temporarily attached to the shaft **1120** could be used to provide the necessary force.

FIG. **6** is a partly ghosted view of a portion of the device **1100**. Those parts shown in FIG. **6** that have already been referred to in relation to FIG. **5**, have been numbered the same. Shaft **1120** has been ghosted to show bell cranks **2060** and **2070**, push button **2120**, and finger spring **2050** therebelow.

FIGS. **7** and **8** are two different perspective views of the securing means **2000**, removed from device **1100**. Those parts of securing means **2000** shown in FIGS. **7** and **8** that have already been referred to in relation to FIG. **5**, have been numbered the same.

FIGS. **9** to **11** of the accompanying drawings show three perspective views of apparatus **3000** according to a fourth embodiment of the present invention in different stages of use. Apparatus **3000** comprises two devices **1100**A and **1100**B, each substantially identical to the aforementioned device **1100**.

In addition to apparatus **3000**, FIGS. **9** to **11** show a rail **3210**, and a rail fastening assembly **3240** which rests upon a sleeper **3300**.

The reference numerals used in respect of device **1100**, also apply to devices **1100**A and **1100**B, except with additional respective suffixes A and B. Accordingly, unnecessary duplicate description of those parts is omitted.

Turning firstly to FIG. **9**, device **1100**A is positioned in its working disposition on one rail fastener housing **3250**A of the rail fastening assembly **3240**. Similarly, device **1100**B is positioned in its working disposition on the other rail fastener housing **3250**B (not shown) of the rail fastening assembly **3240**. A rail fastener **3260**A remains within rail fastener housing **3250**A in a withdrawn position. Another rail fastener (not shown) could remain within rail fastener housing **3250**B in a withdrawn position.

Push button **2120**A is shown in the pushed position, and accordingly locking fingers **2010**A and **2020**A are shown in the unlocked position. Device **1100**A is therefore not secured in its working disposition. Similarly, device **1100**B is also not secured in its working disposition. Devices **1100**A and **1100**B could be lifted away from their working dispositions using carrying straps **1800**A and **1800**B, respectively.

Bearings **1110**A and **1110**B are not in contact with underside faces **3220**A and **3220**B (not shown) of the head section of the rail **3210**, which is therefore not in a lifted position.

In FIG. **10**, push button **2120**A is shown in the released position, and accordingly locking fingers **2010**A and **2020**A are shown in the locked position. Device **1100**A is therefore secured in its working disposition. Similarly, device **1100**B is also secured in its working disposition.

Levers **1230**A and **1230**B are located on handle stubs **1310**A and **1310**B, respectively. Similarly to FIG. **9**, bearings **1110**A and **1110**B (not shown) are not in direct contact with underside faces **3220**A and **3220**B (not shown) of the head section of the rail **3210**, which is therefore not in a lifted position.

In FIG. **11**, devices **1100**A and **1100**B are secured in their working dispositions, as in FIG. **10**. Levers **1230**A and **1230**B have both been rotated by hand so as to bring bearings **1110**A and **1110**B into direct contact with underside faces **3220**A and **3220**B, respectively, of the head section of the rail **3210**. Levers **1230**A and **1230**B have both been further rotated by hand, and due to the mechanical advantage afforded by those levers, the rail **3210** has been lifted upwards. That is, devices **1100**A and **1100**B are shown maintaining the rail **3210** in the lifted position.

Underside faces **3220**A and **3220**B are clean blemish-free surfaces on which bearings **1110**A and **1110**B can run. Bearings **1110**A and **1110**B together ensure that no substantial lateral movement of rail **3210** is permitted. No additional side rollers are required.

FIG. **12** shows a device **1100'** according to a fifth embodiment of the present invention which is similar in many ways to the device **1100** of FIG. **5**. However, the device **1100'** differs from that of FIG. **5** primarily in three ways. Firstly, the carrying strap has been omitted. Secondly, the device **1100'** is provided with a locking mechanism **4000** for keeping the arm **1105** in a vertical position. The locking mechanism **4000** comprises an end piece **4001** of square profile which is attached to the free end of the shaft **1120** and a locking piece **4002** which has a recess **4002***a* shaped to match the square outline of the end piece **4001**, the locking piece **4002** being magnetically attachable to the mount assembly **1150** below the end piece **4001** such that the end piece **4001** abuts the walls of the recess **4002***a*. Thus, rotation of the end piece **4001**, and hence of the shaft **1120**, is prevented when the locking piece **4002** is in position. The locking piece **4002** may be formed, for example, either entirely of magnetic material or, as shown in FIGS. **12**A to **12**E, of a casting with embedded magnets **4003**.

The third change is to the securing means for securing the device to a PANDROL FASTCLIP™ rail fastener housing. In this embodiment, the device **1100'** is provided with securing means **5000** comprising two securing members **5001** provided one on each side of the mount assembly body **1150**. The securing members **5001** are connected together by means of a handle **5002** and, when the handle is in a retracted position (FIGS. **12**B and **12**D), are located within respective bearings **5003**, the end of each securing member **5001** being provided with a stop **5004** for engaging a recess **5005** in the end of the bearing **5003**. When the mount assembly body **1150** of the device **1100'** is located on a rail fastener housing (FIGS. **12**D and **12**E), the securing members **5001** are allowed to drop down under gravity (FIG. **12**E) to lock behind a feature on the fastener housing, securing the device **1100'** in position. Similar mechanisms may be used for other types of fastening.

FIG. **13** shows two tray-form pallets **6000**, stacked one above the other, onto which a number of the devices **1100'** have been loaded for transportation. The pallets **6000** are stackable, slingable and fork-liftable. Each pallet **6000** can hold up to 162 devices **1100'**, which self-lock onto the bars **6001** forming the floor of the pallet **6000**. One of the pallet bars **6001** locates in an acute angle beneath the mount assembly body **1150** and another locates behind the extended securing member **5001**. Thus, when the securing member **5001** is down, the device **1100'** is locked onto the bars **6001** and cannot be removed. Additional bars **6001** are provided on the floor of the pallet **6000** to prevent the devices **1100'** from tipping or falling through as they are loaded.

The invention claimed is:

1. A railway-rail-lifting device for lifting a railway rail, the device comprising:

an arm;

a roller rotatably mounted to the arm, the arm being operable to be rotated to bring the roller to bear on the rail such that the roller exerts a lifting force thereon;

a securing means for releasably securing the device to a rail fastening assembly; and

a transmitting means operable to transmit a force to the arm so as to rotate the arm,

wherein said transmitting means comprises a shaft coupled to the arm, and

wherein the shaft is mounted in an axial bearing.

2. A device as claimed in claim **1**, the rail having a head section and the head section having an underside face, wherein the arm is operable to be rotated such that the roller is brought to bear on a portion of said underside face.

3. A device as claimed in claim **1**, wherein the arm is operable to be rotated such that the roller is brought into direct contact with the rail.

4. A device as claimed in claim **2**, wherein the roller has an outer face having a width extending parallel to the roller's axis of rotation, and wherein the roller is mounted such that said width is substantially parallel with the portion of said underside face when the roller is brought to bear thereon.

5. A device as claimed in claim **1**, wherein the roller is mounted such that its axis of rotation is substantially perpendicular to a longitudinal axis of the rail when the roller is brought to bear on the rail.

6. A device as claimed in claim **1**, wherein the roller is operable, when exerting a lifting force on the rail, to exert a position-maintaining force on the rail so as to resist a movement of the rail.

7. A device as claimed in claim 1, wherein the shaft is mounted in two axial bearings.

8. A device as claimed in claim 1, wherein the shaft is mounted in the axial bearing such that the shaft is operable to be moved axially.

9. A railway-rail-lifting device for lifting a railway rail, the device comprising:

an arm;

a roller rotatably mounted to the arm, the arm being operable to be rotated to bring the roller to bear on the rail such that the roller exerts a lifting force thereon;

a securing means for releasably securing the device to a rail fastening assembly; and

a transmitting means operable to transmit a force to the arm so as to rotate the arm,

wherein said transmitting means comprises a shaft coupled to the arm, and

wherein the shaft is mounted with a washer and circlip, the washer and circlip limiting axial movement of the shaft.

10. A device as claimed in claim 9, wherein the shaft is mounted with two washers and two circlips, the washers and circlips limiting axial movement of the shaft.

11. A device as claimed in claim 9, wherein the washer and circlip enable the roller to exert a position-maintaining force.

12. A railway-rail-lifting device for lifting a railway rail, the device comprising:

an arm;

a roller rotatably mounted to the arm, the arm being operable to be rotated to bring the roller to bear on the rail such that the roller exerts a lifting force thereon; and

a securing means for releasably securing the device to a rail fastening assembly,

wherein the securing means comprises a locking handle operable to secure and release the device.

13. A device as claimed in claim 12, wherein the locking handle is operable by hand.

14. A railway-rail-lifting device for lifting a railway rail, the device comprising:

an arm;

a roller rotatably mounted to the arm, the arm being operable to be rotated to bring the roller to bear on the rail such that the roller exerts a lifting force thereon;

a securing means for releasably securing the device to a rail fastening assembly; and

a rotation limiting means operable to limit the rotation of the arm,

wherein the rotation limiting means is operable to limit the rotation of the arm in such that the arm is operable to be rotated from a horizontal position through an angle of rotation θ.

15. A device as claimed in claim 14, wherein θ is greater than 90 degrees.

16. A device as claimed in claim 15, wherein θ is 100 degrees.

17. A railway-rail-lifting device for lifting a railway rail, the device comprising:

an arm;

a roller rotatably mounted to the arm, the arm being operable to be rotated to bring the roller to bear on the rail such that the roller exerts a lifting force thereon;

a securing means for releasably securing the device to a rail fastening assembly; and

a rotation limiting means operable to limit the rotation of the arm,

wherein said rotation limiting means comprises locking means operable to temporarily lock the arm in a fixed position.

18. A railway-rail-lifting method for lifting a railway rail, the method comprising:

providing a railway rail lifting device including

an arm;

a roller rotatably mounted to the arm;

a securing means for releasably securing the rail lifting device to a rail fastening assembly; and

a transmitting means operable to transmit a force to the arm so as to rotate the arm, the transmitting means including a shaft coupled to the arm, the shaft being mounted in an axial bearing; and

rotating the arm to bring the roller to bear on the railway rail such that the roller exerts a lifting force thereon.

19. Railway-rail-lifting apparatus for lifting a railway rail, the apparatus comprising first and second devices, each of said devices comprising an arm, a roller rotatably mounted on the arm, the arm being operable to be rotated to bring the roller to bear on the rail such that the roller exerts a lifting force thereon, and securing means for releasably securing the device to a rail fastening assembly the rail having a head section and the head section having an underside face, wherein the arm is operable to be rotated such that the roller is brought to bear on a portion of said underside face, wherein the rail has first and second underside faces on opposite sides of the rail, and wherein the arm of a first one of the said devices is operable to be rotated such that the roller of the first device is brought to bear on a portion of said first underside face, and wherein the arm of a second one of the said devices is operable to be rotated such that the roller of the second device is brought to bear on a portion of the second underside face.

20. Apparatus as claimed in claim 19, wherein said first and second devices are operable to exert their respective first and second lifting forces simultaneously.

21. Apparatus as claimed in claim 20, wherein the sum of said first and second lifting forces is at least equal to a force required to lift the rail.

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